Research Proposal of the Thesis Entitled

Analysis into the usability of press wood products in Interior Spaces

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By

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Introduction

Building interiors, once thought of as providing safe shelters from the pernicious effects of outdoor air pollution and harsh climates, may be more polluted than the surrounding ambient environment (Spengler & Chen, n.d.2000). The material choice affects thermal performance, air quality, and outgassing, fire toxicity, cancer-causing fibers, and mold, all of which have an impact on the respiratory and digestive systems, eyes, and skin as stated by Dainoff 1990 (Loftness et al., 2007). Regarding moisture retention and mould growth, finishing materials have a significant impact on the quality of indoor air. According to the Confederation of Industry, IGBC – Indian Green Building rating council, in an updated addendum of 2019, identified that 90% of the time people stay indoors. These areas serve as a home or a place of employment.

The father of Architecture, Sir Le Corbusier quotes in the book Towards a New Architecture- *"It is our business to use materials and constructional methods to our hand, not, of course, blindly, but with a constant endeavor to improve them"*

The interior volume is closely related to the user's health and safety from the same point of view. According to measurements, indoor pollution is 10 times more likely to occur than outdoor pollution(Ye et al., 2017). Today, material application in the interior has become a "one-size-fits-all" attitude, which leads to the use of materials without analyzing their application. The most of of these toxins are connected to volatile organic compounds (VOC), which are organic chemical pollutants. It is important to highlight the prospect of Design correlation. As VOC is present in a gaseous state, it is characterized by Indoor Air and its Quality measures. Attitudes to well-being have prioritized the endurance of healthy lives and promoting well-being for all. As referred by (Spengler & Chen, n.d.) in reference to the document Environmental Allergy: Definitions, Causes, Control. A relatively recent phenomenon, this enormous rise in harmful health effects is linked as a potential cause to the symptoms that have been reported in buildings.

Products made of pressed wood, such as particle board and plywood, are significant emitters

of formaldehyde indoors.(Elbert, 1995 & Meyer & Hermanns, 1985)

Within the context of its use in interior spaces, the field of study on pressed wood products focuses on differentiating interior space parameters. The research paper tries to look into the scientific method to justify the use of pressed wood products such as medium-density fiber(MDF), veneer, plywood etc., which are majorly used for interior elements. Formaldehyde (HCHO) is the major emitted source from the earlier stated material.(Bayer & Black, 1989).

The study has been conducted using large scale environmental chamber (LSTC) techniques.(Bayer & Black, 1989). Comparative analysis test has been conducted at larger scale with Laboratory-Scale Evaluation Chamber, Full-Scale Evaluation Chamber, Test Case in a Real Building have been conducted using miniaturized sensors; portable device. (Goletto et al., 2020). American association of heating, refrigerating and air-conditioning engineers (ASHRAE) measures have been considered standard in many studies conducted for indoor air quality. (Sedzani Sandra Ndou, 2007) Questionnaire survey was also a methodology adopted.(Andamon et al., 2019). Formaldehyde is frequently regarded separately from other volatile chemicals because the methods of gas chromatography commonly used for VOC studies are incapable of identifying it. (Maroni, M., Seifert, B., & Lindvall, T. (1995). Indoor Air Quality - A Comprehensive Reference Book. Amsterdam: Elsevier. Mathematical and analytical approach has also been undertaken for understanding formaldehyde concentration in indoor environment. (M~lhave & Bisgaard, 1983). Experimental and computer methods are obtainable for studying and designing indoor air quality and a computer-based approach using computational fluid dynamics (CFD), is a influential design tool of the future.(Spengler & Chen, n.d.)

Review of Literature

- (Andersen et al., 1975)A mathematical model and field measurement technique were explored for understanding formaldehyde concentration, within a room was established. The material used was particle board. The result pinpointed the need of creating air quality standards.
- (Gupta et al., 1982) through the survey done with desicator test method of the users and their time of duration, and its adverse effect on body part. The research clearly states – “Formaldehyde levels in indoor air are almost always higher than in outdoor

air.”

- (Molhave & Bisgaard, 1983),used scale factor in measuring or calculating formaldehyde concentration from particle boards. This was done through a mathematical model and small-scale model room. The model can also be used to determine the highest allowable mean emission rates for a given room in context of Danish standard of formaldehyde emission.
- (Plckrell et al., 1984), conducted a dynamic ventilated chamber system, for press wood products with respect environmental change and emission of formaldehyde with other products. The study states that, there is no substantial effect in temperature and humidity changes in affect formaldehyde release. The other finding of the experiment suggests, relevance of particle board and other material involvement as carpets, plywood and insulation material. These dual combination helps in reduction of formaldehyde level, as water present in second product absorbs formaldehyde given off by particle board.
- (Matthews et al., 1986) Using a Formaldehyde Surface Emission Monitor (FSEM) in research homes, study of the formaldehyde (CH2O) emission rates from particleboard, hardwood plywood paneling, and medium density fibre (MDF) products manufactured in the United States has been conducted. This increases the practice of engineering's supremacy.
- (Godish et al., 1989) has done experiment on coating over the formaldehyde. It was concluded for at the control measure study as a retrofit method at source before being applied. Baseline method was adopted for pre and post application of coating. Temperature, humidity, were kept constant in a conventional home. It stated that different coatings do have different effects on the emission of formaldehyde, though it was done only for single coating application only.
- (Danko et al., 1990) discusses towards the need to think for health in respect to interior design teaching and practicing. The research tries to set goals to put forth a framework that clarifies the importance of daily interior design decision-making for professionals and educators while trying to offer a framework for additional study.
- (Yu & Crump, 1998) highlights how the creation of different voluntary labelling systems, local government regulations, and early as possible VOC emission data-bases from materials would increase market demand for low-emitted products.

- The World Health Organization has issued guidelines for formaldehyde inhalation ("WHO Guidelines for Air Quality.," 1998), stating that long-term health effects like cancer can be avoided by adhering to the short-term (30-minute) guideline of 0.1 mg/m3. A formaldehyde indoor air standard is appropriate. since indoor exposure is the primary source of personal exposure through breathing, and indoor applications can be high enough to produce significant wellbeing consequences.
- (Dingle et al., 2000) have done preliminary experiments using plants to purify the unhealthy indoor air. According to the findings, plants don't seem to be an effective way to remove formaldehyde and require a lot of them to see any discernible decrease in concentrations.
- (Trosa & Pizzi, 2001) focuses on the performance and emission results of hardeners for tannin-based adhesives used in particleboard and plywood. This is in relation to the production of low formaldehyde emission wood panels, with a focus on the manufacturing process.
- (Lavoué et al., 2005) investigates the manufacturing plants. In Quebec's reconstituted wood panel industry, several factors that affect formaldehyde exposure were found through statistical modelling of area and individual exposure measurements. The possibility of greater short-term exposure was observed, and this cannot go unnoticed.
- (Risholm-Sundman et al., 2007) establishes the necessity for the International Standard Organization (ISO). The study examines various approaches used to measure formaldehyde. It talks about various test scenarios, sample treatments on medium density fiberboard(MDF), particleboard, ply wood and solid wood.
- (Zhang et al., 2007) conducted an experiment involving an airtightness test, formaldehyde injection, and related formula method work. Through both methods, it can be determined that temperature has a significant impact on. However, it noted that more research was required in order the ability to precisely forecast the partition coefficient and the impact of temperature on the diffusion rate of particular building materials.
- Verganti, R. (2009) in his Book-*Design driven innovation: changing the rules of competition by radically innovating what things mean*' makes a clear – "While engineers and economists have developed sophisticated methods for improving product performance and manifest-effectiveness technology, less is known about

how to engage positive cognitive and emotional responses in users(design)". This identifies the sensitivity that a designer need to further undertake.

- World Health Organization. (2010). *WHO guidelines for indoor air quality: selected pollutants*. World Health Organization. Regional Office for Europe., gives guidelines target audiences include experts and officials involved in the design and use of structures, interior materials, and products, as well as public health professionals who work to prevent health risks associated with environmental exposures. They give standards that are enforceable by law a scientific foundation.
- (Chi et al., 2016) taking samples from 3122 households, features of household indoor pollution was evaluated for TVOC and formaldehyde. The study verifies that formaldehyde and TVOC concentrations in indoor air can be influenced by a variety of factors, including decoration materials, daily activities, and human consumption. it can be segregated as volatile sources, combustion sources and composite sources. Time as a factor for emission is signified further in details as decorative pollution, consumption pollution and transition pollution. Here, it is also concluded that formaldehyde is sensitive to temperature and humidity.
- (Ghaffarianhoseini et al., 2018) relates sick building syndromes (SBS) with material. The study emphasizes the importance of the built environment and comes to the conclusion that there should be no single formula for research on SBS and creating healthy indoor environments because any health-related building design guidelines depends on many interrelated factors.
- (Wi et al., 2020) The small chamber method was used to analyse the formaldehyde (HCHO) and total volatile organic compounds (TVOC) content of 2780 different building products. It assesses whether or not the material meets the legal standards. It has been observed that legal standards have inspired manufacturers to create technologies that lessen the release of dangerous substances, lowering the amount of pollutants in indoor air.
- Few building terminologies came through literature study:

  Building Research Establishment= BRE

  American Society of Heating, Refrigerating and Air-Conditioning Engineers= ASHRAE

  Environmental Protection Act=EPA

  Sick Building Syndromes=SBS

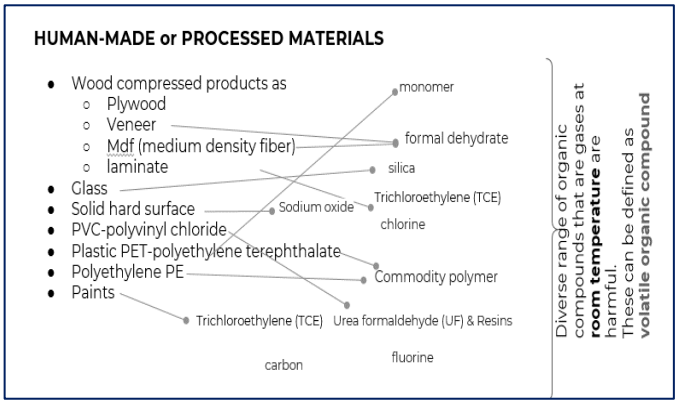
Indian Green Building Codes=IGBC

Formaldehyde=HCHO

Volatile organic compound=VOC

Problem Statement

Few studies have investigated the co factors which effect in emission of formaldehyde in the particle boards, etc. Currently, there are results inferred for the parameters of temperature and humidity. Till date, no studies have been conducted in context to quantification effect in respect to Interior Space for the pressed wood products. The ignorance in relation of interior spaces with need to quantifying the material utilization needs to be looked into, which might develop a strategy for use of particle boards or press wood products.



Schematic mapping processed material emission

Aim

To investigation into displacement of Volatile Organic Compounds on basis of quantitative use of pressed wood products in interior space.

Objectives

1. To study the effects due to use of pressed wood products as an Interior Material, in respect to the release of volatile organic compounds(VOC).
2. To identify the factors of Indoor Space conditions that influence in the emission of VOC.
3. To determine the correlation between the quantification of press wood products and emission of volatile organic compounds through a specific typology of Interior Space
4. To frame a proposal to balance the use of press wood products in Interior spaces

Rationale

Understanding the correlation between the emission causes of pressed wood factors in interior spaces shall help in developing effective mathematical method or a strategies as part in controlling the volatile organic compound emission, and to re-think strategy in Interior Space Planning.

A fact – (Danko et al., 1990) Volatile organic compounds (VOCs) and other contaminants that are released over an extended period of time from sources such construction materials, paints, stains, varnishes, various fabrics, and floor and wall coverings, even in small levels, can pose a health risk.

Motivation

Random use of pressed wood product is done due to their easy availability, quick installation & cost effectiveness. Hence, it becomes a fast and easy solution many times to use it. But, the after-effects that it creates go ignored. Cross fields as such engineering, material science have done a substantial work for volatile organic compound. But, its translation to its ground field in interior spaces seems nil.

Identifying and bridging the factors to be considered in use of pressed wood material will become imperative part of study.

Research Questions

1. What is the consequence in use of pressed wood products in indoor spaces?
2. What is the effective causes of emission of volatile organic compounds in indoor spaces?
3. What is the association factors between pressed wood products and emission of volatile organic compounds in context to only indoor space application?
4. What could be the framework for balancing the use of pressed wood products in regard to indoor space?

Hypothesis

H0 – Null Hypothesis

There is no significant association between emission of volatile organic compounds and pressed wood products to be considered in Indoor Space Planning

H1 – Alternative Hypothesis

There is a significant association between emission of volatile organic compounds and pressed wood products to be considered in Indoor Space Planning

Methodology

1. Literature Review
   - Problem statement
   - Literature review
   - Research gap
   - Aim & Objectives

2. Research Design
   - Conduct survey based on appropriate techniques
   - Independent & Dependent variables to conduct survey

3. Data Collection
   - Factors / Parameters measured:
     Volume of the space
     Quantity of the material
     Indoor conditions

4. Analysis of Result
   - Regression method
   - Simulative method

5. Hypothesis testing
   - Strategy for reduction of volatile organic compound(VOC) emission in deference to use of press wood products

6. Final Documentation

Expected Outcomes

1. Gain a database for factors directly connected to volatile organic compound emission in respect to Interior Spaces
2. Create a set of guidelines for use of pressed wood products at an initial stage of interior space planning and detailing.
3. Develop analytical and holistic strategies to prevent health issues caused due to over use of the pressed wood materials in Interior Spaces

Limitations

The research is not looking into the embodied energy in trade of press wood products and neither is it demanding to do in manufacturing sector of the press wood

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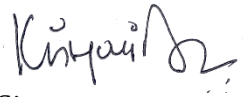

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